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(54) **Suspension assembly**

Suspensionseinheit

Ensemble de suspension

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Description

[0001] The present invention relates to a suspension assembly for a high-clearance vehicle having a forward direction of travel and a first operating clearance height, the suspension assembly including an upright spindle journal, a main suspension spindle received in said journal for rotating and sliding within said journal, and a wheel hub mounting bracket being coupled to a lower end of said main suspension spindle. Such an assembly is disclosed in German Patent No. DE-C-913735.

[0002] Currently, there is a trend for application of late season fungicide to corn crops. The height of the corn crop during this time requires that the chemical be applied by via airplane sprayers or by self-propelled high-clearance agricultural sprayers having a ground-to-under frame clearance of about 76 inches to ensure minimal damage to crop. While there are commercially available sprayers that have the required clearance, these machines compromise stability, from a tip over standpoint, since side-to-side wheel spacing must be maintained in order to match conventional corn row spacing.

[0003] The high clearance for a known agricultural sprayer is provided by coupling elongate spindles between the main frame of the sprayer and each of four wheel support and motor housings, with each spindle being mounted for sliding in upright journal areas of knee joints, that form an integral part of an axle assembly, and with each spindle having an air bag suspension mounted to an upper end of the spindle. U.S. Patent No. 7,168,712 discloses a high-clearance agricultural sprayer having spindles mounted in this fashion so as to provide the operating clearance.

[0004] The problem to be solved then is to provide a high-clearance sprayer vehicle which demonstrate desired stability from a tip over standpoint during the majority of the spraying season but which has sufficient clearance for applying chemicals to corn plants later in the spraying season.

[0005] The problem will be solved by the teaching of claim 1. Advantageous embodiments are defined within the subclaims.

Accordingly the spacer assembly for increasing said clearance height being optionally connected between said lower end of said main suspension spindle and said wheel hub mounting bracket.

[0006] The above mentioned suspension assembly provides a structure for selectively increasing the ground-to-under frame clearance of a high clearance sprayer vehicle without modifying the spacing between wheels at opposite sides of the vehicle.

[0007] The spacer assembly might be selectively inserted between the bottom of the main suspension spindle and the wheel hub mounting bracket, with the lower end of the spacer assembly carrying a coupler spindle coupled to the wheel hub mounting bracket and being offset from the pivot axis of the main spindle by a distance which results in the wheel contacting the same location

of the ground as it did when the wheel hub mounting bracket was mounted directly to the main suspension spindle.

[0008] The spacer assembly, according to one construction, is defined by upper and lower spacer castings, with the upper casting being secured to the bottom of the main suspension spindle, and with the lower spacer casting being bolted to the upper spacer casting and carrying the coupler spindle at an offset location relative to the axis of the main suspension spindle.

[0009] The foregoing and other objects will become apparent from a reading of the ensuing description together with the appended drawings.

[0010] Fig. 1 is a schematic, left front perspective view of a prior art high-clearance vehicle chassis incorporating elongate suspension spindles for achieving the high-clearance height.

[0011] Fig. 2 is a front view, with parts removed of the left front spindle suspension of the prior art chassis shown in Fig. 1.

[0012] Fig. 3 is a view like Fig. 1, but showing the spacer assembly of the present invention coupled between the bottom of the suspension spindle and the combined drive motor housing and wheel hub mounting bracket.

[0013] Fig. 4 is an exploded perspective view showing the spacer assembly and its connection with the main and coupler spindles, and the connection of the coupler spindle with the combined drive motor housing and wheel hub mounting bracket.

[0014] Referring now to Fig. 1, there is shown a chassis 10 of a high-clearance agricultural vehicle, such as a self-propelled agricultural field sprayer, having a fore-and-aft extending main frame 12 supported for movement over the ground by front and rear sets of wheels 14 and 16, respectively. A rear sprayer boom support 28 is located on a central rear location of the main frame 12. The high-clearance sprayer vehicle may be generally of the type shown and described in the aforementioned U.S. Patent No. 7,168,717.

[0015] A steering and suspension system, indicated generally at 30, includes a four wheel independent spindle suspension having at least two steerable ground wheel assemblies 36 and 38 mounting the front set of wheels 14 and supported at opposite ends of a front axle structure 40. A rear axle structure 42 is provided at the rear of the frame 12 and supports non-steerable wheel assemblies 46 and 48, respectively mounting the wheels 16 outwardly of the sprayer boom support 28. Hydraulic drive motors 50 and 52 are connected to the wheels 14 and 16, respectively, and to a conventional controlled source of hydraulic fluid under pressure (not shown) on the sprayer vehicle to provide vehicle driving power.

[0016] The suspension system includes substantially similar adjustable, front and rear cushioning structures 60 and 62, respectively, supported above main front and rear suspension spindles 66 and 68, respectively. The front suspension spindles 66 are respectively supported within a pair of front spindle journals 70 forming an inte-

gral part of opposite ends of the front axle structure 40, the spindles 66 being mounted for rotation and axial movement in the journals 70. Not being steerable, the rear spindles 68 are supported only for axial movement within the journals 72, which form integral end portions of the rear axle structure 42. Lower ends of each of the front spindles 66 are secured to front housings 74 containing the wheel motors 50 and serving also as wheel hub mounting brackets for the wheels 14. Similarly, lower ends of each of the rear spindles 68 are secured to rear housings 76 containing the wheel motors 52 and serving also as wheel hub mounting brackets for the wheels 16.

[0017] As shown in Fig. 1, the middle of the front wheels 14 contact the ground at respective points P, which are spaced apart by a distance T corresponding to a desired spacing of the wheels 14 so that they may be driven between adjacent rows of standing corn plants in rows spaced from each other by a standard desired distance.

[0018] Referring now to Fig. 2, it can be seen that the left front suspension journal 70 makes an angle of 10° relative to a vertical plane extending in the direction of travel of the chassis 10 and that a longitudinal axis A1 of the main suspension spindle 66 intersects the ground at the point P which is at the middle of the wheel 14 mounted to the housing 74.

[0019] Referring now to Fig. 3, there is shown the structure of the present invention for increasing the working clearance height of the chassis 10, noting that while only a structure for increasing the working height of the left front suspension spindle 66 is shown, it is to be understood that a similar structure is applied to each of the suspension spindles 66 and 68 so as to increase the working clearance height of the chassis 10. With respect to the left front main suspension spindle 66, it can be seen that instead of being mounted directly to the housing 74, the bottom of the spindle 66 is mounted to a spacer assembly 80, which, in turn is mounted to the housing 74 by a coupler spindle 82. The coupler spindle 82 is disposed along an axis A2 extending parallel to, and offset inwardly from, the axis A1, the offset being chosen such that the axis A2 intersects the ground at the point P, while the axis A1 intersects the ground at a point outwardly of the point P. Thus, even though the distance between the ground and the inclined main spindle 66 has increased, the distance by which the coupler spindle axis A2 is offset from the main spindle axis A1 is such as to compensate for this increase so that no change occurs in the spacing P between the wheels 14 when the spacer assemblies 80 are installed.

[0020] As can best be seen in Fig. 4, the spacer assembly 80 includes separate upper and lower spacer castings 84 and 86, respectively. The upper spacer casting 84 has an upper region provided with a cylindrical bore 88 having the same dimensions as a cylindrical bore 90 provided in the top of the housing 74. The bottom end of the main suspension spindle 66 is provided with a diametrically extending slot 92 which becomes aligned with diametrically opposite recesses (not shown) provided at

a bottom end location of the bore 88. A key 94 is snugly received within the slot 92 and has opposite ends received in the recesses of the bore 88. A flat circular plate 96 is received in the bottom of the bore 88 and has diametrically opposite tabs received in the recesses. A bolt 98 projects upwardly through aligned holes respectively provided in the center of the plate 96 and the key 94 and is tightened into a threaded bore extending axially into the bottom of the main suspension spindle 66 so as to tightly secure the upper spacer casting 84 for rotation with the spindle 66.

[0021] The bottom end of the lower spacer casting 86 is provided with a cylindrical bore (not visible) that is also sized identically to the bore 90 provided in the top of the housing 74. The coupler spindle 82 is relatively short and includes upper and lower ends respectively provided with upper and lower, diametrically extending slots 100 and 102. A top end of the bore in the lower end of the lower spacer casting 86 and the bottom end of the bore 90 provided in the housing 74 are respectively provided with diametrically opposite recesses (not shown) that are in alignment with the slots 100 and 102. Connecting hardware (not shown) identical to the key 94, plate 96 and bolt 98, described above for coupling the upper spacer casting 84 to the main spindle 66, is used for coupling the top end of the coupler spindle 82 to the lower spacer casting 86 and for coupling the lower end of the coupler spindle 82 to the housing 74.

[0022] The lower end of the upper spacer casting 84 defines a flat U-shaped coupling surface 104, while the upper end of the lower spacer casting 86 defines a similarly shaped flat U-shaped coupling surface 106 that is rotated 180° relative to the surface 104 so that a pair of tapped and threaded bores (not visible) respectively provided at end regions of the U-shaped coupling surface 104 are in axial alignment with a pair of through bores extending through the closed end of the coupling surface 106 and containing clamping bolts 108 that are tightened within the threaded bores. Similarly, located at the end regions of the lower U-shaped surface are the upper ends of threaded and tapped holes 110 which extend into the lower spacer casting 86 and are in alignment with through bores having lower ends (not visible) located in the closed end of the U-shaped surface 104, these through bores containing clamping bolts 112 (only one shown) that project downwardly and are tightened into the threaded and tapped holes 110. A pair of dowels 114 are provided in aligned holes in each of the limbs of the U-shaped surfaces 104 and 106 which ensure that the upper and lower spacer castings 84 and 86 are properly oriented relative to each when they are being coupled together, thereby ensuring that the axis A2 of the coupler spindle 82 is correctly offset from axis A1 of the main spindle 66.

[0023] Thus, it will be appreciated that, by using spacer assemblies 80, one can provide a relatively large increase to the operating clearance height of a high-clearance vehicle, such as an agricultural sprayer, without altering the spacing between the wheels at the opposite

sides of the vehicle. Further, it will be appreciated that instead of being made from two separate castings, the spacer assembly could be made as a single part.

[0024] Having described the preferred embodiment, it will become apparent that various modifications can be made without departing from the scope of the invention as defined in the accompanying claims.

Claims

1. A suspension assembly (30) for a high-clearance vehicle having a forward direction of travel and a first operating clearance height, the suspension assembly (30) including an upright spindle journal (70, 72), a main suspension spindle (66, 68) received in said journal (70, 72) for rotating and sliding within said journal (70, 72), and a wheel hub mounting bracket (74, 76) being coupled to a lower end of said main suspension spindle (66, 68), **characterized in comprising**; a spacer assembly (80) for increasing said clearance height being optionally connected between said lower end of said main suspension spindle (66, 68) and said wheel hub mounting bracket (74, 76).
2. The suspension assembly (30), as defined in claim 1, wherein said spacer assembly (80) includes upper and lower ends respectively provided with identically sized upper and lower bores (88) and a coupler spindle (82) having an upper end located within said lower bore; said upper bore (88) receiving a bottom end of said main suspension spindle (66, 68); a first coupler assembly (92, 94, 96) fixing said spacer assembly for rotation with said main suspension spindle (66, 68); said wheel hub mounting bracket (74, 76) having a third bore (90) located in an upper end thereof; said coupler spindle (82) having a bottom end section projecting downwardly from said spacer assembly and being received in said third bore (90); and second and third coupler assemblies (92, 94, 96) respectively fixing said coupler spindle (82) to said spacer assembly (80) and to said wheel hub mounting bracket (74, 76) member.
3. The suspension assembly (30), as defined in claim 2, wherein said upright spindle journal (70, 72) is inclined outwardly from a vertical plane extending parallel to said direction of travel; and said lower bore of said spacer assembly (80) extending parallel to said upper bore (88) and being offset inwardly from said upper bore (88) by a distance which compensates for the spacing between the bottom of the main suspension spindle (66, 68) and the hub mounting bracket (74, 76) so that a wheel (14, 16) mounted to the hub when no spacer assembly (80) is used will contact the ground in the same location as it does when the spacer assembly (80) is used.

4. The suspension assembly (30), as defined in one of the claims 2 to 4, wherein said spacer assembly (80) includes separate upper and lower castings (84, 86) which are coupled together; said upper casting (84) being provided with said upper bore (88) and said lower casting (86) being provided with said lower bore.

Patentansprüche

1. Radaufhängungsanordnung (30) für ein Fahrzeug mit hoher Bodenfreiheit, das eine Vorwärtsbewegungsrichtung und eine erste Höhe der Bodenfreiheit im Betrieb aufweist, wobei die Radaufhängungsanordnung (30) einen aufrecht stehenden Spindellagerzapfen (70, 72), eine zum Drehen und Gleiten in dem Lagerzapfen (70, 72) in dem Lagerzapfen (70, 72) aufgenommene Hauptaufhängungsspindel (66, 68) und eine Radnabenbefestigungshalterung (74, 76), die mit einem unteren Ende der Hauptaufhängungsspindel (66, 68) gekoppelt ist, enthält, **dadurch gekennzeichnet, dass** sie Folgendes umfasst: eine Abstandshalteranordnung (80) zum Erhöhen der Bodenfreiheit, die wahlweise zwischen dem unteren Ende der Hauptaufhängungsspindel (66, 68) und der Radnabenbefestigungshalterung (74, 76) verbunden ist.
2. Radaufhängungsanordnung (30) nach Anspruch 1, wobei die Abstandshalteranordnung (80) ein oberes und ein unteres Ende enthält, die mit einer oberen bzw. unteren Bohrung (88), die gleich dimensioniert sind, und einer Koppelspindel (82) mit einem sich in der unteren Bohrung befindenden oberen Ende versehen sind, wobei die obere Bohrung (88) ein unteres Ende der Hauptaufhängungsspindel (66, 68) aufnimmt; eine erste Koppelanordnung (92, 94, 96) die Abstandshalteranordnung zur Drehung mit der Hauptaufhängungsspindel (66, 68) befestigt; die Radnabenbefestigungshalterung (74, 76) eine dritte Bohrung (90) aufweist, die sich in einem oberen Ende davon befindet; wobei die Koppelspindel (82) einen unteren Endabschnitt aufweist, der sich von der Abstandshalteranordnung nach unten erstreckt und in der dritten Bohrung (90) aufgenommen ist; und eine zweite und dritte Koppelanordnung (92, 94, 96) die Koppelspindel (82) an der Abstandshalteranordnung (80) bzw. dem Radnabenbefestigungshalterungsglied (74, 76) befestigen.
3. Radaufhängungsanordnung (30) nach Anspruch 2, wobei der aufrecht stehende Spindellagerzapfen (70, 72) von einer parallel zur Fahrtrichtung verlaufenden vertikalen Ebene nach außen geneigt ist; und sich die untere Bohrung der Abstandshalteranordnung (80) parallel zur oberen Bohrung (88) erstreckt und von der oberen Bohrung (88) um eine Entfer-

nung nach innen versetzt ist, die den Abstand zwischen dem unteren Teil der Hauptaufhängungsspindel (66, 68) und der Nabenbefestigungsanordnung (74, 76) ausgleicht, so dass ein an der Nabe befestigtes Rad (14, 16), wenn keine Abstandshalteranordnung (80) verwendet wird, den Boden an derselben Stelle berührt wie bei Verwendung der Abstandshalteranordnung (80).

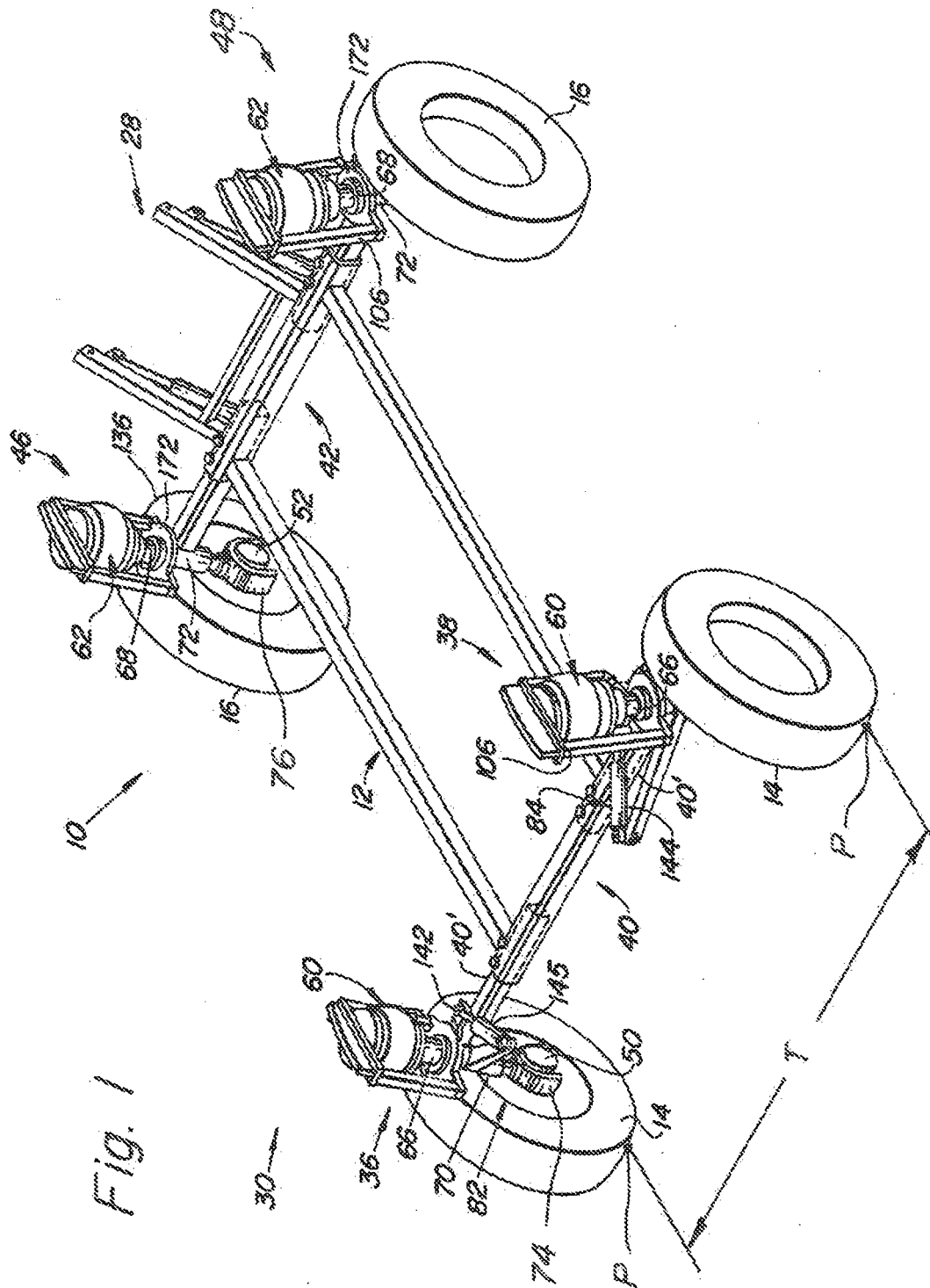
4. Radaufhängungsanordnung (30) nach einem der Ansprüche 2 bis 4, wobei die Abstandshalteranordnung (80) ein oberes und unteres Gussteil (84, 86) enthält, die getrennt sind und miteinander gekoppelt sind; wobei das obere Gussteil (84) mit der oberen Bohrung (88) versehen ist und das untere Gussteil (86) mit der unteren Bohrung versehen ist.

Revendications

1. Ensemble de suspension (30) pour un véhicule à garde au sol élevée ayant un sens de déplacement avant et une première hauteur de garde au sol de service, l'ensemble de suspension (30) comprenant un palier de tige vertical (70, 72), une tige de suspension principale (66, 68) reçue dans ledit palier (70, 72) afin de tourner et de coulisser à l'intérieur dudit palier (70, 72), et un support de fixation de moyeu de roue (74, 76) accouplé à une extrémité inférieure de ladite tige de suspension principale (66, 68), **caractérisé en ce qu'il** comprend un ensemble d'espacement (80) servant à augmenter ladite hauteur de garde au sol et éventuellement raccordé entre ladite extrémité inférieure de ladite tige de suspension principale (66, 68) et ledit support de fixation de moyeu de roue (74, 76).
2. Ensemble de suspension (30), tel que défini dans la revendication 1, ledit ensemble d'espacement (80) comprenant des extrémités supérieure et inférieure respectivement dotées d'alésages supérieur et inférieur (88) de taille identique et une tige d'accouplement (82) comportant une extrémité supérieure située à l'intérieur dudit alésage inférieur ; ledit alésage supérieur (88) recevant une extrémité inférieure de ladite tige de suspension principale (66, 68) ; un premier ensemble d'accouplement (92, 94, 96) fixant ledit ensemble d'espacement en vue de sa rotation avec ladite tige de suspension principale (66, 68) ; ledit support de fixation de moyeu de roue (74, 76) comportant un troisième alésage (90) situé dans une extrémité supérieure de celui-ci ; ladite tige d'accouplement (82) comportant une section d'extrémité inférieure faisant saillie vers le bas à partir dudit ensemble d'espacement et étant reçue dans ledit troisième alésage (90) ; et des deuxième et troisième ensembles d'accouplement (92, 94, 96) fixant respectivement ladite tige d'accouplement (82) audit

ensemble d'espacement (80) et audit organe formant support de fixation de moyeu de roue (74, 76).

3. Ensemble de suspension (30), tel que défini dans la revendication 2, ledit palier de tige vertical (70, 72) étant incliné vers l'extérieur à partir d'un plan vertical s'étendant parallèlement audit sens de déplacement ; et ledit alésage inférieur dudit ensemble d'espacement (80) s'étendant parallèlement audit alésage supérieur (88) et étant décalé vers l'intérieur par rapport audit alésage supérieur (88) d'une distance qui compense l'espacement entre la partie inférieure de la tige de suspension principale (66, 68) et le support de fixation de moyeu (74, 76) de telle sorte qu'une roue (14, 16) montée sur le moyeu, lorsqu'aucun ensemble d'espacement (80) n'est utilisé, va venir en contact avec le sol au même endroit que lorsque l'ensemble d'espacement (80) est utilisé.
4. Ensemble de suspension (30), tel que défini dans l'une des revendications 2 à 4, ledit ensemble d'espacement (80) comprenant des pièces coulées supérieure et inférieure (84, 86) individuelles qui sont accouplées l'une avec l'autre ; ladite pièce coulée supérieure (84) étant dotée dudit alésage supérieur (88) et ladite pièce coulée inférieure (86) étant dotée dudit alésage inférieur.



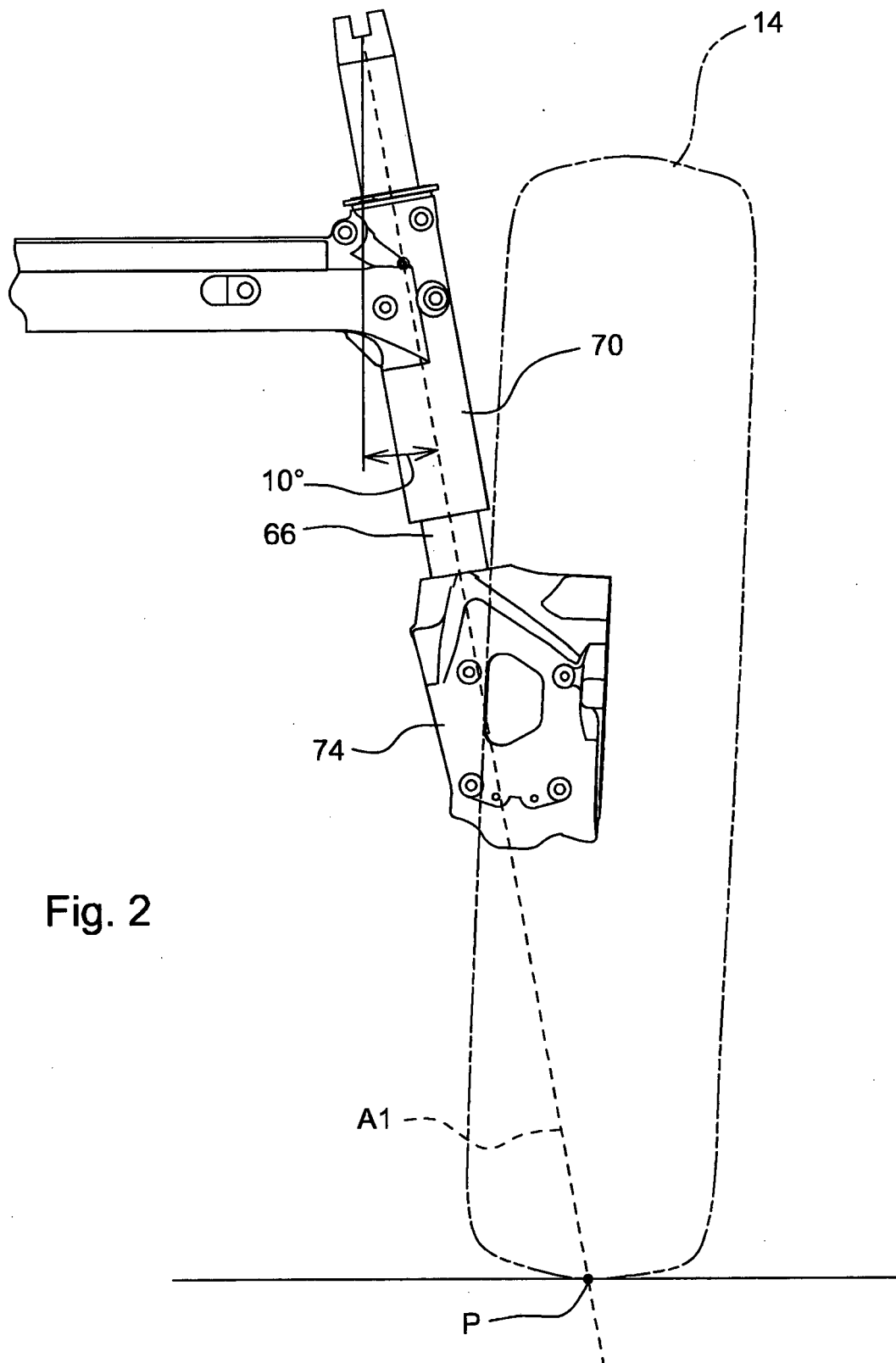


Fig. 2

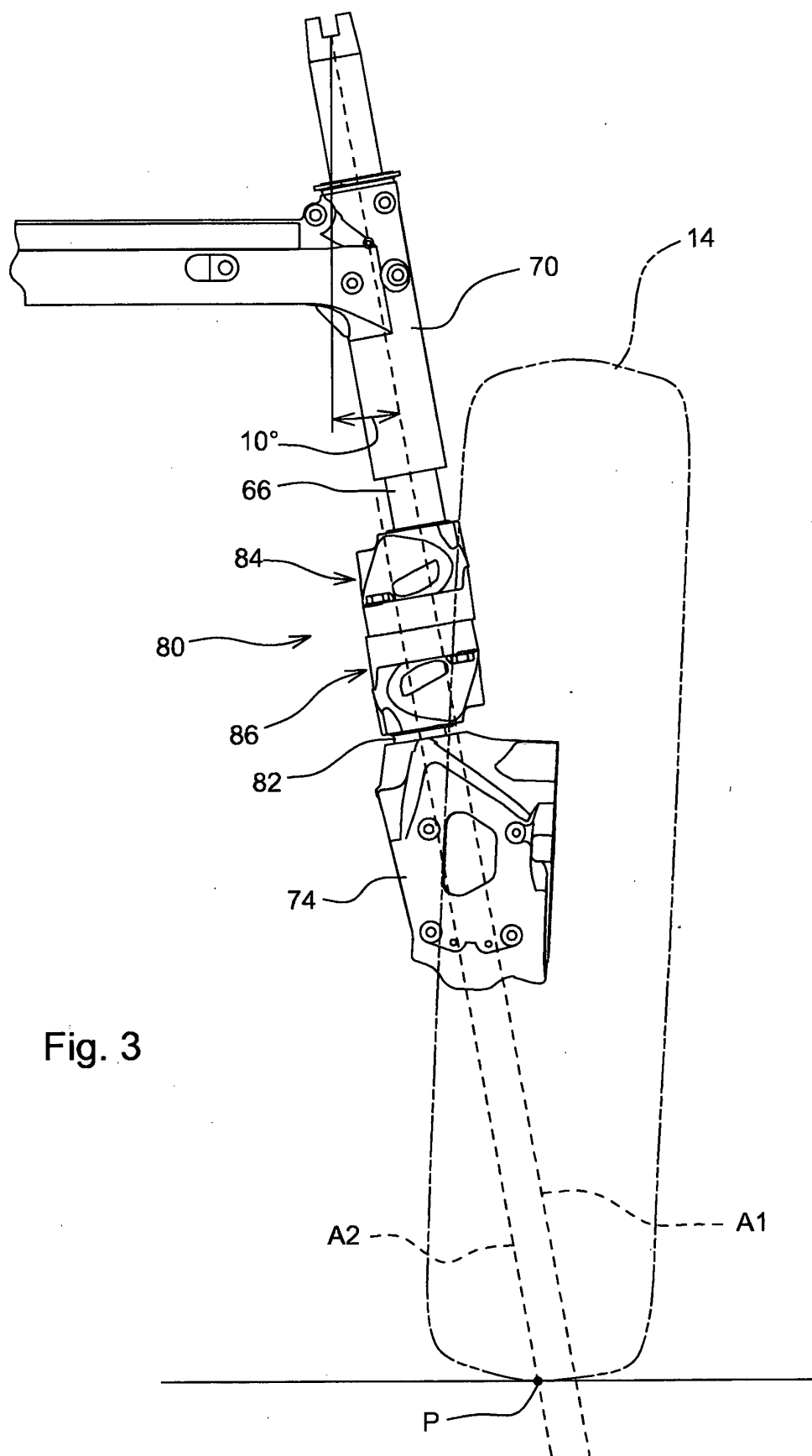


Fig. 3

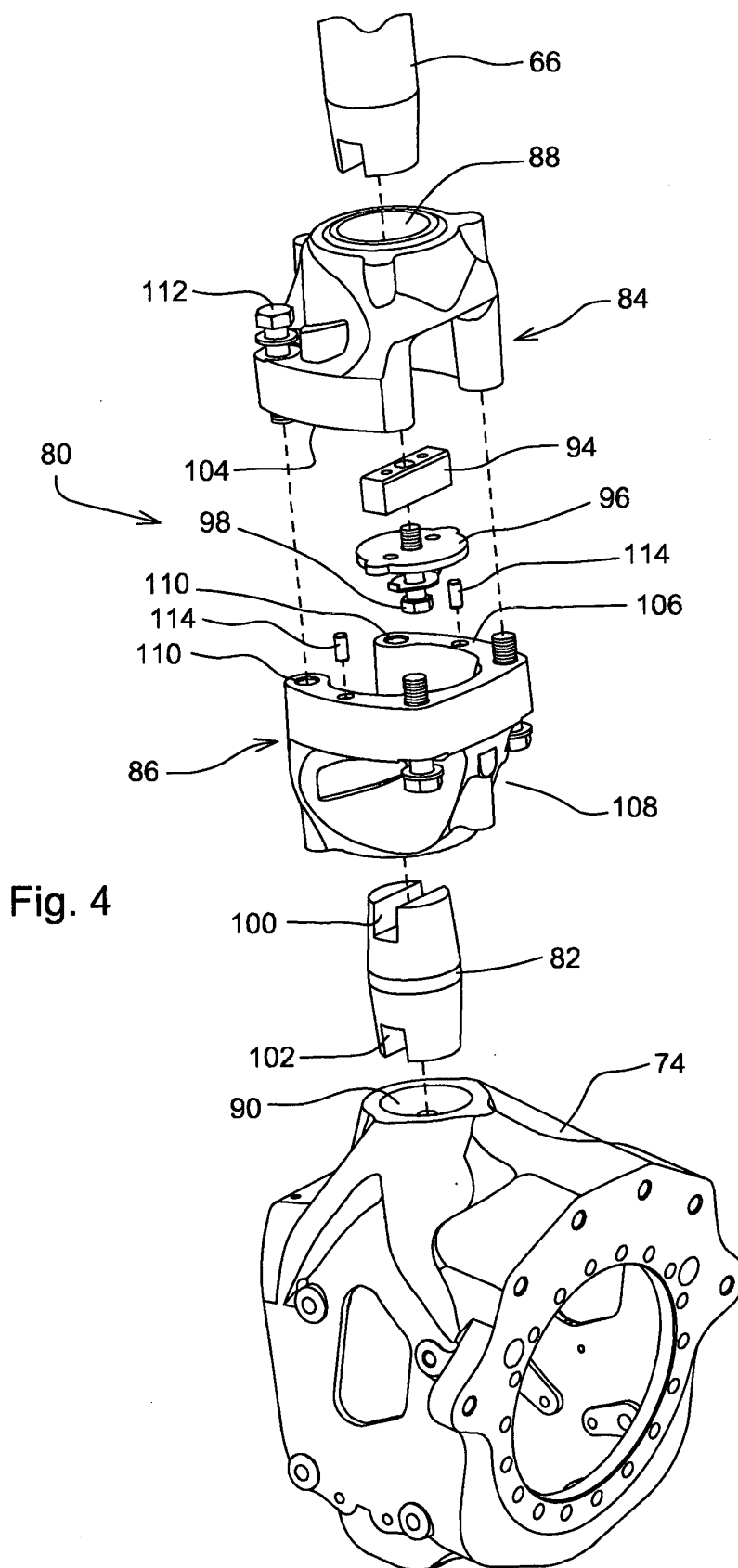


Fig. 4

REFERENCES CITED IN THE DESCRIPTION

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